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NL-16-098

September 6, 2016

U.S. Nuclear Regulatory Commission
Document Control Desk
11545 Rockville Pike, TWFN-2 F1
Rockville, MD 20852-2738

SUBJECT: Licensee Event Report # 2015-007-01, "Manual Reactor Trip Due to Decreasing Steam Generator Water Level Caused by a Miss-Wired Circuit Board in the Main Feedwater Pump Speed Control System"
Indian Point Unit No. 3
Docket No. 50-286
DPR-64

Reference: 1. Licensee Event Report # 2015-007-00, letter NL-15-115, dated September 8, 2015

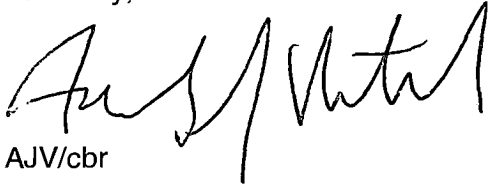
Dear Sir or Madam:

Pursuant to 10 CFR 50.73(a)(1), Entergy Nuclear Operations Inc. (ENO) hereby provides Licensee Event Report (LER) 2015-007-01. The attached LER is a revision to an LER submitted by Reference 1, that identified an event where the reactor was manually tripped, which is reportable under 10 CFR 50.73(a)(2)(iv)(A). As a result of the reactor trip, the Auxiliary Feedwater System was actuated, which is also reportable under 10 CFR 50.73(a)(2)(iv)(A). This condition was recorded in the Entergy Corrective Action Program as Condition Report CR-IP3-2015-03795. Four I&C Maintenance procedures were identified for revision in Reference 1, but further review determined that two procedures do not require revision as they are not associated with MBFP speed control. It was also determined that two speed control calibration procedures for the 22 MBFP and 32 MBFP did require revision. As a result of degraded unplanned scrams performance indicator, further evaluation was performed and a revised root cause evaluation issued. Changes as a result of additional evaluations are included in this LER revision.

IE22
NRR

There are no new commitments identified in this letter. Should you have any questions regarding this submittal, please contact Mr. Robert Walpole, Manager, Regulatory Assurance at (914) 254-6710.

Sincerely,

A handwritten signature in black ink, appearing to be 'AJV/cbr', written in a cursive style.

cc: Mr. Daniel H. Dorman, Regional Administrator, NRC Region I
NRC Resident Inspector's Office, Indian Point Energy Center
Ms. Bridget Frymire, New York State Public Service Commission

LICENSEE EVENT REPORT (LER)

Estimated burden per response to comply with this mandatory collection request: 80 hours. Reported lessons learned are incorporated into the licensing process and fed back to industry. Send comments regarding burden estimate to the Records and FOIA/Privacy Service Branch (T-5 F53); U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by internet e-mail to infocollects.resource@nrc.gov, and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB-10202, (3150-0104), Office of Management and Budget, Washington, DC 20503. If a means used to impose an information collection does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to, the information collection.

1. FACILITY NAME: INDIAN POINT 3

2. DOCKET NUMBER
05000-2863. PAGE
1 OF 6

4. TITLE: Manual Reactor Trip Due to Decreasing Steam Generator Water Levels Caused by a Miss-Wired Circuit Board in the Main Feedwater Pump Speed Control System

5. EVENT DATE			6. LER NUMBER			7. REPORT DATE			8. OTHER FACILITIES INVOLVED	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REV. NO.	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBER
7	8	2015	2015	007 - 01		9	6	2016		05000

9. OPERATING MODE	11. THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check all that apply)			
1	<input type="checkbox"/> 20.2201(b)	<input type="checkbox"/> 20.2203(a)(3)(i)	<input type="checkbox"/> 50.73(a)(2)(i)(C)	<input type="checkbox"/> 50.73(a)(2)(vii)
	<input type="checkbox"/> 20.2201(d)	<input type="checkbox"/> 20.2203(a)(3)(ii)	<input type="checkbox"/> 50.73(a)(2)(ii)(A)	<input type="checkbox"/> 50.73(a)(2)(viii)(A)
	<input type="checkbox"/> 20.2203(a)(1)	<input type="checkbox"/> 20.2203(a)(4)	<input type="checkbox"/> 50.73(a)(2)(ii)(B)	<input type="checkbox"/> 50.73(a)(2)(viii)(B)
	<input type="checkbox"/> 20.2203(a)(2)(i)	<input type="checkbox"/> 50.36(c)(1)(i)(A)	<input type="checkbox"/> 50.73(a)(2)(iii)	<input type="checkbox"/> 50.73(a)(2)(ix)(A)
	<input type="checkbox"/> 20.2203(a)(2)(ii)	<input type="checkbox"/> 50.36(c)(1)(ii)(A)	<input checked="" type="checkbox"/> 50.73(a)(2)(iv)(A)	<input type="checkbox"/> 50.73(a)(2)(x)
	<input type="checkbox"/> 20.2203(a)(2)(iii)	<input type="checkbox"/> 50.36(c)(2)	<input type="checkbox"/> 50.73(a)(2)(v)(A)	<input type="checkbox"/> 73.71(a)(4)
	<input type="checkbox"/> 20.2203(a)(2)(iv)	<input type="checkbox"/> 50.46(a)(3)(ii)	<input type="checkbox"/> 50.73(a)(2)(v)(B)	<input type="checkbox"/> 73.71(a)(5)
	<input type="checkbox"/> 20.2203(a)(2)(v)	<input type="checkbox"/> 50.73(a)(2)(i)(A)	<input type="checkbox"/> 50.73(a)(2)(v)(C)	<input type="checkbox"/> OTHER
	<input type="checkbox"/> 20.2203(a)(2)(vi)	<input type="checkbox"/> 50.73(a)(2)(i)(B)	<input type="checkbox"/> 50.73(a)(2)(v)(D)	

Specify in Abstract below or in NRC Form 366A

12. LICENSEE CONTACT FOR THIS LER

NAME
James Timone, Engineering Systems E-FINTELEPHONE NUMBER (Include Area Code)
(914) 254-6733

13. COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO EPIX	CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO EPIX
B	SJ	ECBD	L253	Y	X	SD	MO	W120	Y

14. SUPPLEMENTAL REPORT EXPECTED

☐ YES (If yes, complete 15. EXPECTED SUBMISSION DATE) ☒ NO

15. EXPECTED SUBMISSION DATE

MONTH DAY YEAR

16. ABSTRACT (Limit to 1400 spaces, i.e., approximately 15 single-spaced type written lines)

On July 8, 2015, during surveillance testing, the Control Room received a 6.9kV motor trip alarm due to 31 Condensate Pump (CP) Motor circuit breaker trip on overcurrent. Operators entered Alarm Operating Procedure 3-AOP-FW-1 due to loss of the 31 CP and initiated a load reduction. During this time the Main Boiler Feedwater Pump (MBFP) suction pressure decreased to its suction pressure cutback controller pressure range and its output decreased MBFP speed control to a minimum. The 31 MBFP speed control signal locked in at this minimum speed signal due to actuation of the MBFP Lovejoy speed control system Track and Hold feature. Due to this minimum 31 MBFP condition, the 31 MBFP recirculation valve opened causing the 31 MBFP check valve to close. With the 31 MBFP unloaded, Steam Generator (SG) water levels decreased and at 15 percent operators manually tripped the reactor. The Auxiliary Feedwater System automatically started as expected due to SG low level from shrink effect. Direct cause was the 31 MBFP entered a Hold condition erroneously due to a miss-wired Track and Hold board in the speed control system. The root cause was the procurement for the MBFP Lovejoy Track and Hold boards was at an insufficient quality level commensurate with its criticality. There was a failure to mandate functional testing and wiring verification requirements on the vendor to ensure the procurement of a quality product. Corrective actions included replacement of MBFP track and hold board and 31 CP motor. A new replacement Track and Hold circuit board for both the 31 and 32 MBFP speed control system with the miss-wiring corrected was installed. The quality levels for the Track and Hold boards were revised from Q4 to Q3. MBFP Lovejoy speed control maintenance procedures and site vendor manuals were revised to include more detail. The event had no effect on public health and safety.

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NARRATIVE (If more space is required, use additional copies of NRC Form 366A) (17)

Note: The Energy Industry Identification System Codes are identified within the brackets {}.

DESCRIPTION OF EVENT

On July 8, 2015, while at 100 percent reactor power, during performance of surveillance test 3-PT-Q100B (Turbine First Stage Analog Channel B Calibration), the Control Room {NA} received a 6.9kV motor trip alarm {ALM} due to 31 Condensate Pump (CP) {KA} Motor circuit breaker {BKR} trip on overcurrent. Operators entered Alarm Operating Procedure 3-AOP-FW-1 due to loss of the 31 CP and initiated a load reduction to 900 MWe. During this time the Main Boiler Feedwater Pump (MBFP) {SJ} suction pressure decreased to its suction pressure cutback controller PC-409A pressure range (265 psig to 230 psig) and its output decreased MBFP speed control to a minimum. The 31 MBFP speed control signal locked in at this minimum speed signal due to actuation of the MBFP Lovejoy speed control system {JB} Track and Hold feature. Due to this minimum 31 MBFP condition, the 31 MBFP recirculation valve BFD-FCV-1115 opened causing the 31 MBFP check valve to close. With the 31 MBFP unloaded, Steam Generator (SG) {AB} water levels decreased and at 15 percent operators manually tripped the reactor {JC}. All control rods {AA} fully inserted and all required safety systems functioned properly. After the RT the 32 Component Cooling Water (CCW) pump auto started while adjusting temperature control valve TCV-130. The plant was stabilized in hot standby with decay heat being removed by the main condenser {SG}. The Auxiliary Feedwater System {BA} automatically started as expected due to SG low level from shrink effect. The Emergency Diesel Generators {EK} did not start as offsite power remained available and stable. The RT event was recorded in the Indian Point Energy Center corrective action program (CAP) as CR-IP3-2015-03795. A post trip evaluation was initiated and completed on July 8, 2015.

The main feedwater (FW) system consists of two steam turbine driven pumps which receives condensate and heater drains in its suction and provides the final boost in pressure and temperature to provide FW to the SGs. The MBFPs speed is controlled automatically to provide FW header pressure greater than SG pressure. Low suction pressure protection is needed to prevent cavitation in the MBFP. There are two low suction pressure protection circuits, 1) PS-521 provides suction pressure protection by automatically starting the standby Condensate Booster Pumps, 2) PT-408B provides a signal to controller PC-409A to initiate the low suction pressure MBFP turbine speed cutback. This cutback starts at approximately 265 psig and automatically reduces MBFP turbine speed as a function of suction pressure to a minimum (approximately 3,000 rpm). There is a MBFP Turbine (MBFPT) control oil system whose purpose is to adjust the position of the high and low pressure stop valves and high and low pressure governor valves based on the signal from the MBFP speed control system. The speed of the MBFP turbine is controlled with a combination of electric, pneumatic, and hydraulic controls. The Lovejoy Control System which converts the electrical output of the Foxboro Control System into an equivalent control oil pressure signal to control the Westinghouse Boiler Feed Pump's turbine speed control system.

For normal operations MBFP speed is controlled automatically by an auto-manual speed controller. Each MBFP (2) has its own speed controller (SC-408 and SC-409). Each MBFP speed signal is compared to a MBFP suction pressure signal by low current detectors (SM-408B and SM-409B). The low current selectors choose the lower of the two signals to pass on to the MBFP speed changers as follows: 1) Pressure Transmitter PT-408B senses pump suction pressure and sends a signal to suction pressure cutback controller PC-409A.

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Pressure controller PC-409A is programmed to generate a full output signal for any suction pressure above 265 PSI and ramp down to minimum output for a suction pressure of 230 PSI. During normal operation of the MBFP, suction pressure is 370 PSI, well above 265 PSI and the FW signal will be selected by the low current selector and passed on to the speed changers. 2) If the pump suction pressure falls below 265 PSI, the pressure signal will begin decreasing until it falls below the value of the FW signal. At this point the low current selector will pass the suction pressure signal to the Lovejoy signal processor thereby limiting MBFP speed to maintain suction pressure.

The Lovejoy Control System has a Track and Hold circuitry (card or circuit board) whose function is to protect the system against a loss of FW demand signal from the Foxboro Loop. There are three permissives that allow the system to go into HOLD mode: rate change of the signal, signal being at low or high setpoints, and signal remaining at this value for more than a ½ second. The Track and Hold cards contain a potentiometer that is used to adjust rate of change setting that will trigger first permissive for a HOLD condition. The second permissive is met by having FW demand signal be at either the low or high setpoints. The third permissive is made up if the signal remains at the high or low setpoint value for more than ½ second. An unstated function is that the permissives will clear when required.

The Lovejoy System receives a 2 year preventive maintenance (PM) calibration every refueling outage (RO) per procedure 3-IC-PC-I-31MBFP. Instrument and Control personnel perform this PM under the guidance of a Lovejoy technical representative every RO. The 2 year PM does not have steps to test the Track and Hold functions that are controlled by a microprocessor. Only the Track and Hold card percent FW digital display is calibrated during the 2 year PM. The primary function of the Track and Hold board to enter a hold condition upon loss of FW demand signal is tested. Testing is not performed to ensure erroneous hold conditions are not entered.

On July 13 2015, a troubleshooting team was assembled including Lovejoy representatives to determine the cause of the false Hold conditions. On July 14, 2015, the refurbished Track and Hold card installed after the RT was Lab tested. During testing it was identified that the potentiometer used to set rate of change permissive was wired incorrectly. This resulted in Rate of Change permissive being constantly armed. Thus, with the rate of change permissive satisfied, the Track and Hold card would actuate HOLD mode once the FW signal went to minimum for greater than ½ second. The faulty Track and Hold card was miss-wired during manufacturing at the Lovejoy Controls Facility. Entergy reviewed the Track and Hold card testing performed at Lovejoy Controls on new cards and the calibration performed by I&C during a 2 year PM. Neither of these testing procedures contained sufficient details to detect the incorrectly wired rate of change potentiometer. A performance analysis worksheet was completed to analyze the knowledge and skills of applicable site personnel. The assessment concluded that site personnel over rely on the vendor (Lovejoy) for troubleshooting and maintenance of the MBFP speed control system and that refresher training is recommended. The MBFP speed control system Track and Hold circuit board (CAT ID 0018475019) {ECBD} is manufactured by Lovejoy {L253}.

After the RT the 31 Condensate Pump motor was tested and a winding short was detected. A spare motor was installed. The 31 Condensate Pump motor was rewound at Schulz Electric in 2003 and installed in the 31 Condensate Pump position in 2005. During RO 3R17 in 2013, the motor was removed for its 8 year PM overhaul then reinstalled at the end of the RO. During the 2013 overhaul of this motor, a hot spot in the stator core was identified by the vendor during the extended core loss test which was accepted by the vendor. The vendor recommended epoxy penetration repair was performed to allow motor service until the 2019 overhaul.

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A core loss test can be performed by the vendor during refurbishment/rewind to identify localized hot spots due to degraded stator core laminations, but no core loss test was performed. The vendor recommended performing a restack of the core during the next scheduled overhaul in 2019.

To address the identified hot spot, the stator was dipped in varnish, underwent a vacuum pressure impregnation process which pulls the varnish into voids including the suspect inter-laminar insulation between steel sheets and the stator placed in an oven to bake and cure the varnish. During 3R18 in 2015, the motor was lifted and the 2 year offline electrical testing performed satisfactorily and the motor was returned to service.

An extent of condition investigation determined that Unit 3 remains susceptible to a manual or automatic RT due to low SG levels on decrease in FW suction pressure, which would occur with a loss of Condensate Pump or Heater Drain Pumps. SG level rapidly lowering and FW flow rapidly decreasing have a medium risk based upon a high consequence of a RT on low SG level within approximately 30 seconds with no operator action. Actions have been taken to address the risk and reduce it to a low probability. The actions include replacement and refurbishment of aging FW flow and SG level controllers and testing and replacement of installed and testing of spare Track and Hold Boards. The Unit 2 Track and Hold Boards in the warehouse were found to have their rate of change potentiometers miss-wired. They were returned to Lovejoy, re-wired and returned to IPEC and functionally tested satisfactory.

The Cause of Event

The direct cause of the RT was lowering SG levels and the inability to maintain SG levels. The decrease in FW flow was due to the 31 MBFP Lovejoy speed control system entering a Hold condition erroneously due to a miss-wired speed control Track and Hold circuit board. The miss-wired Track and Hold board resulted in the rate of change permissive continuously being made up. The Track and Hold cards contain a potentiometer that is used to adjust rate of change setting that will trigger first permissive for a Hold condition. The potentiometer used to set rate of change permissive was wired incorrectly so that it satisfied the rate of change permissive. This condition resulted in the Rate of Change permissive being constantly armed. With the Rate of Change permissive satisfied, the Track and Hold card would actuate Hold mode once the FW signal went to minimum for greater than ½ second.

The direct cause of the 31 Condensate Pump motor fault was a localized hot spot in the stator core due to aged core insulation that caused a winding fault in the 31 Condensate Pump motor. For localized hot spots identified during the core loss test, there is no set criterion of when a restack of the core should be performed. Industry guidance only provides that a repair should be performed.

The root cause of the RT was the procurement for the MBFP Lovejoy Track and Hold boards was at an insufficient quality level commensurate with its criticality. The root cause resulted in this event when an untested unverified board of the MBFP speed control system erroneously entered the hold mode. Indian Point failed to mandate functional testing and wiring verification requirements on the vendor to ensure the procurement of a quality product. The Track and Hold boards were procured as non-safety related quality level 4 (Q4). This resulted in procurement of the board solely based on its part number. This failure mode describes a situation where the process does not specify the completion of tasks that are needed to ensure successful completion. This failure mode includes the case where a procedure is required or prudent, but not provided.

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This malfunction would not block a hold condition from occurring which is the primary design function of the board upon loss of input FW demand signal but instead would result in an erroneous track and hold when minimum FW demand signal is obtained. This is what occurred during the plant event when the MBFP speed cutback was initiated following the MBFP suction pressure decreasing below 265 psig when the 31 Condensate Pump motor tripped

Corrective Actions

The following are some of the corrective actions that have been or will be performed under the Corrective Action Program (CAP) to address the causes of this event.

- The 31 MBFP speed control Track and Hold circuit board was replaced.
- The 31 Condensate Pump was replaced with a spare.
- A TEAR (#IPEC-2015-321) was prepared and submitted for refresher Lovejoy training for I&C Technicians. Training for I&C technicians was approved for 2017.
- The I&C MBFP Lovejoy speed control procedures (2-IC-PC-I-E-21MBFP, 3-IC-PC-I-E-31MBFP, 2-IC-I-E-22MBFP, 3-IC-I-E-32MBFP) were revised to include more detail to functionally check all mission critical board functions. Additionally, the Track and Hold rate adjustment potentiometer setting was documented with a range in the procedure. Steps were included to check the functions of the Track and Hold board and to adjust the rate potentiometer as necessary.
- The site vendor manuals will be revised to provide sufficient details to adequately troubleshoot and understand the functionality of the Lovejoy speed control system. Lovejoy Controls Corporation provided necessary updates to the vendor manual which requires engineering review and approval.
- A Supplier Quality Performance Data Tracking (SQPDTP) was issued for the Lovejoy miss-wiring of the Track and Hold circuit board. Negative entry has been made into the supplier quality performance data tracking database.
- The Track and Hold circuit board for the 31 MBFP Lovejoy speed control system was replaced with a new board with the miss-wiring corrected.
- The Track and Hold circuit board for the 32 MBFP Lovejoy speed control system was replaced with a new board with the miss-wiring corrected.
- The procurement quality levels for IP2 (CAT ID 00C1577972) and IP3 (CAT ID 0018475019) were revised from Q4 (non-safety related) to Q3 (augmented quality).
- The CAT ID descriptions were revised to require Lovejoy to test all functions and perform independent wiring verification for all mission critical Lovejoy circuit boards for Unit 2 and 3. The CAT ID's were revised to require Lovejoy to: Test all functions of the Track and Hold Board, that the Hold feature is actuated when the following permissives are met and clears when the permissives clear: rate change of the signal, and signal at low or high setpoints, and high or low signal remaining for more than a ½ second. Have independent verification performed on the wiring configuration of the Track and Hold Board. Documentation of the functional testing and the independent verification to be provided in the test report that Lovejoy will provide with the shipment. By revising the procurement level from Q4 to Q3 results in a QC receipt inspection when the boards are received at IPEC that verifies that Lovejoy met the purchase order requirements for testing and documentation.

Event Analysis

The event is reportable under 10CFR50.73(a)(2)(iv)(A). The licensee shall report any event or condition that resulted in manual or automatic actuation of any of the systems listed under 10CFR50.73(a)(2)(iv)(B). Systems to which the requirements of 10CFR50.73(a)(2)(iv)(A) apply for this event include the Reactor Protection System (RPS) including RT and AFWS actuation.

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This event meets the reporting criteria because a manual RT was initiated at 14:27 hours, on July 8, 2015, and the AFWS actuated as a result of the RT. On July 8, 2015, a 4-hour non-emergency notification was made to the NRC at 15:37 hours, for an actuation of the reactor protection system {JC} while critical and included an 8-hour notification under 10CFR50.72(b)(3)(iv)(A) for a valid actuation of the AFW System (Event Log #51211).

As all primary safety systems functioned properly there was no safety system functional failure reportable under 10CFR50.73(a)(2)(v). The Track and Hold circuit board is a non-safety related part and does not perform a safety function therefore not applicable to reporting under 10CFR21.

Past Similar Events

A review was performed of the past three years for Licensee Event Reports (LERs) reporting a RT as a result of main FW reduction. One LERs was identified that reported a RT due to a FW event, LER-2014-001 reported an automatic RT as a result of a steam flow/feedwater flow mismatch with low 33 SG water level due to the failure of the 33 SG FW flow controller. The decreasing SG level was due to reduced FW flow from closure of the 33 FW regulating valve as a result of the failure of its flow controller. This event was similar but concerned the failure of the FW regulating valve not the speed control system of the MBFP. Corrective actions for that event would not have prevented this event.

Safety Significance

This event had no effect on the health and safety of the public. There were no actual safety consequences for the event because the event was an uncomplicated reactor trip with no other transients or accidents. Required primary safety systems performed as designed when the RT was initiated. The AFWS actuation was an expected reaction as a result of low SG water level due to SG void fraction (shrink), which occurs after a RT and main steam back pressure as a result of the rapid reduction of steam flow due to turbine control valve closure.

There were no significant potential safety consequences of this event. The Reactor Protection System (RPS) is designed to actuate a RT for any anticipated combination of plant conditions to include low SG level. The reduction in SG level and RT is a condition for which the plant is analyzed. A low water level in the SGs initiates actuation of the AFWS. Redundant safety SG level instrumentation was available for a low SG level actuation which automatically initiates a RT and AFWS start providing an alternate source of FW. The AFW System has adequate redundancy to provide the minimum required flow assuming a single failure. The analysis of a loss of normal FW (UFSAR Section 14.1.9) shows that following a loss of normal FW, the AFWS is capable of removing the stored and residual heat plus reactor coolant pump waste heat thereby preventing either over pressurization of the RCS or loss of water from the reactor. In addition, Operators for this event anticipated a possible low SG level and initiated a manual RT. The manual actuating devices are independent of the automatic trip circuitry and are not subject to failures which make the automatic circuitry inoperable. There are two manual trip buttons in the control room. Either one of these buttons will directly energize the trip coils of the reactor trip and bypass breakers in addition to de-energizing the undervoltage coils of the reactor trip and bypass breakers. For this event, rod control was in manual and all rods inserted upon initiation of a RT. The AFWS actuated and provided required FW flow to the SGs. RCS pressure remained below the set point for pressurizer PORV or code safety valve operation and above the set point for automatic safety injection actuation. Following the RT, the plant was stabilized in hot standby.